# United States Patent [19]

**Petersen**

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[54] **LOW-STRESS SHIELDED EXHAUST PASSAGE ASSEMBLIES**


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[51] **Int. Cl.**[4] ..... **F01N 7/10**

[52] **U.S. Cl.** ..... **60/322;** 60/323; 285/261

[58] **Field of Search** ..... 60/282, 302, 322, 323; 285/187, 261, 302



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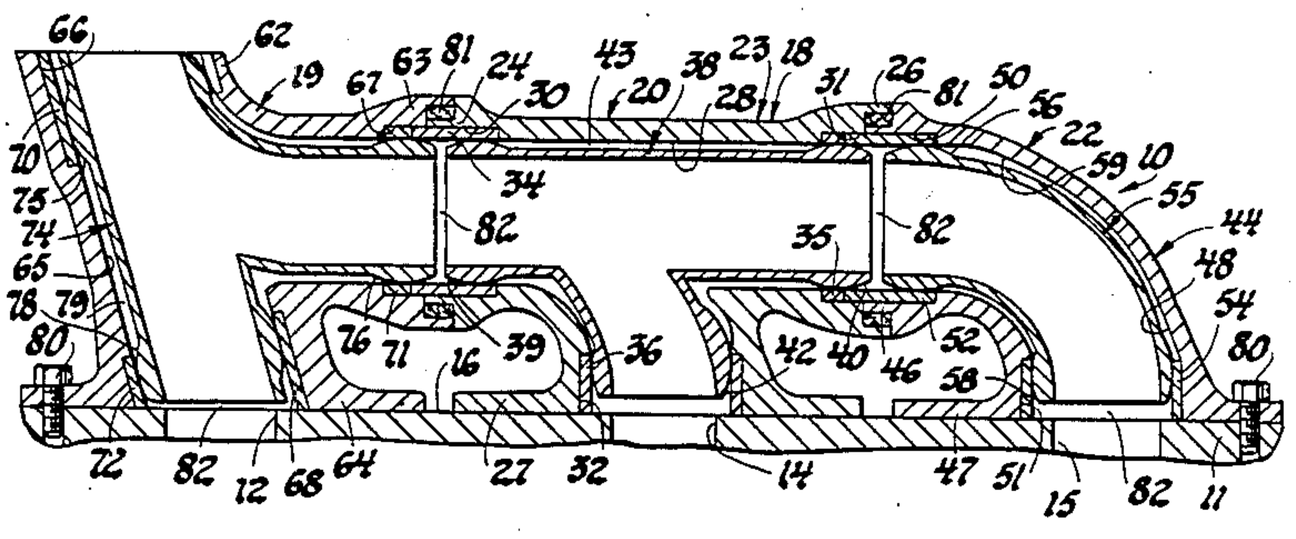
[57] **ABSTRACT**

An exhaust manifold, cylinder head, or the like, is provided with one or more insulating shield members formed within associated housing members having ball or cylindrical end portions. The end portions are seated on bearing rings preferably cast or inserted into the housing ends to provide for relative expansion of the internal shields with respect to the outer housing members, both linear and bending expansion motions being accommodated. The resulting passage assemblies may be formed by casting the housing members around their respective shields. Sand core material may be preapplied to create the desired insulating clearance between the associated members and, if desired, to secure the bearing rings in position.


**8 Claims, 6 Drawing Figures**



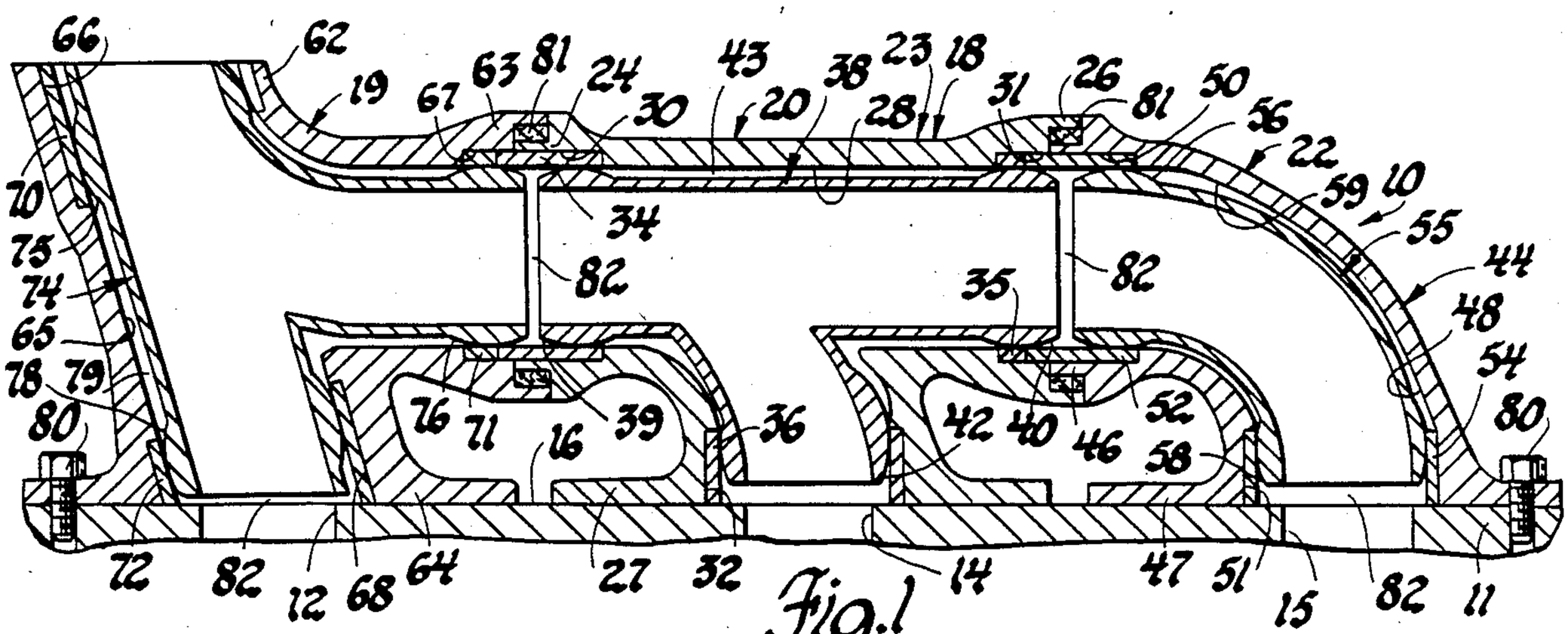



Fig.1

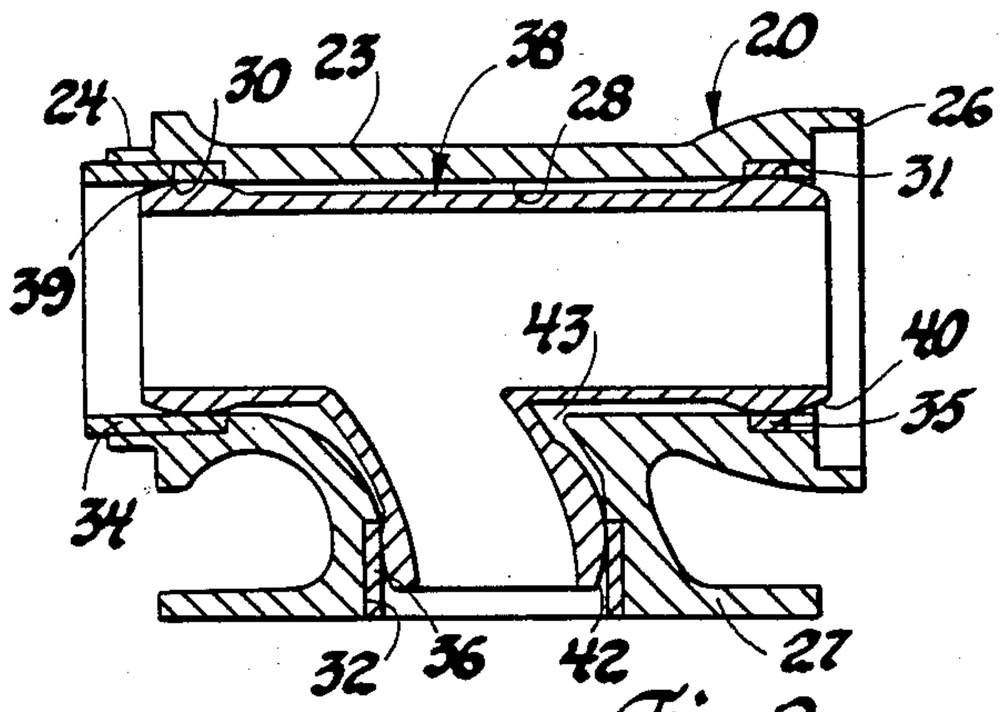



Fig.2

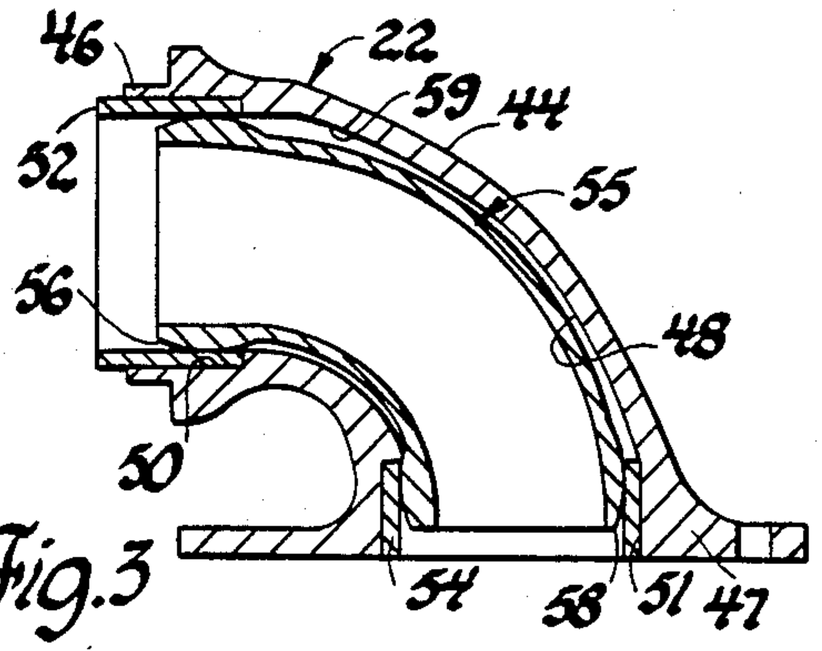



Fig.3

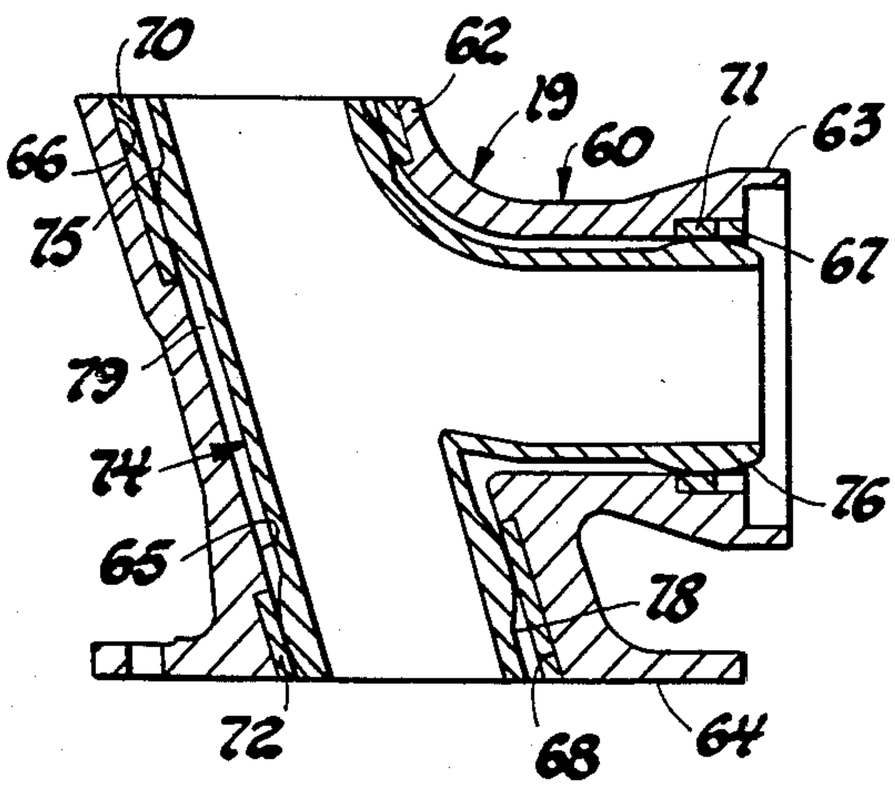



Fig.4

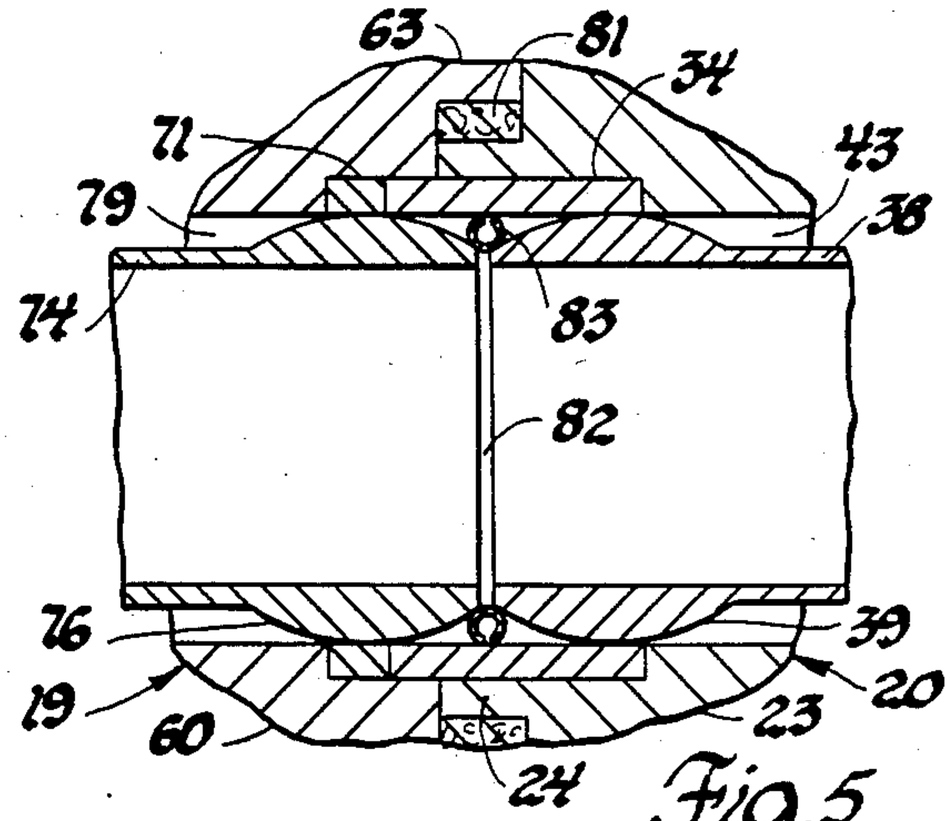



Fig.5

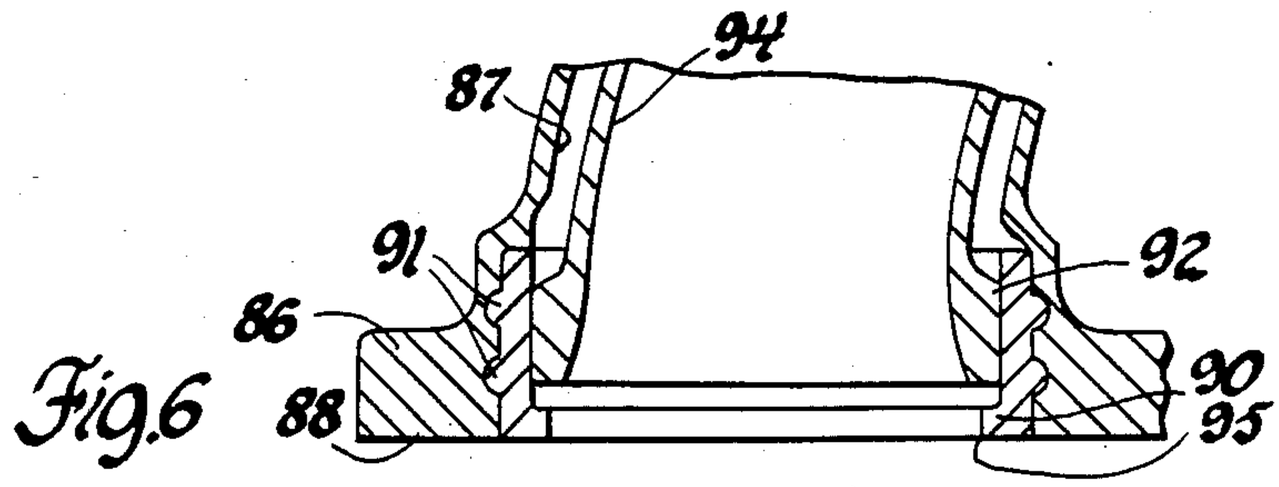



Fig.6

# LOW-STRESS SHIELDED EXHAUST PASSAGE ASSEMBLIES

## FIELD

This invention relates to shielded exhaust passage assemblies, such as engine exhaust manifolds, cylinder heads and the like. In particular, the invention relates to low-stress shielded exhaust passage assemblies and methods for their construction.

## BACKGROUND

It is known in the art relating to internal combustion engines and the like to provide shields, or inner passage defining members, in exhaust passage means such as cylinder head exhaust ports, exhaust manifolds and the like. Various types of shields, or inner linings, have been provided for different purposes. One purpose has been to insulate the exhaust passages to reduce the outer skin temperature. Another has been to reduce the loss of engine exhaust heat prior to delivery to another device such as an exhaust turbocharger for using the high temperature exhaust energy or an exhaust treatment device such as a catalytic converter for supporting combustion reactions in the exhaust gases.

Depending upon the construction of and materials used in such shielded exhaust passage assemblies, the temperature changes occurring in the exhaust systems may result in severe stresses due to differential expansion of various portions of the inner shield members and the outer housing members. However, slip joints and other devices have been previously used to accommodate such stresses.

## INVENTION SUMMARY

The present invention provides improved forms of low-stress shielded exhaust system assemblies for engine exhaust manifolds, cylinder heads and equivalent devices. Novel internal shield arrangements having slip jointed end connections with the housing members of their respective assemblies are utilized to provide low cost, low-stress shielded exhaust passage assemblies capable of manufacture by currently available techniques.

These and other features and advantages of the invention will be more fully understood from the following description of selected embodiments taken together with the accompanying drawings.

## DRAWINGS

In the drawings:

FIG. **1** is a cross-sectional view of an engine having a modular exhaust manifold made up of low-stress shielded exhaust system assemblies formed in accordance with the invention.

FIG. **2** is a cross-sectional view of the center assembly of the manifold of FIG. **1**.

FIG. **3** is a cross-sectional view of the inlet end assembly of the manifold of FIG. **1**.

FIG. **4** is a cross-sectional view of the outlet end assembly of the manifold of FIG. **1**.

FIG. **5** is a cross-sectional view showing an optional arrangement for sealing the gaps between the ends of the shields of adjacent manifold sections, and

FIG. **6** is a cross-sectional view showing an optional form of shield mounting arrangement in an exhaust system assembly.



## DESCRIPTION

In the drawings, numeral **10** generally indicates an internal combustion engine having a cylinder head **11** including a plurality of axially aligned exhaust ports **12**, **14**, **15** opening through an outer wall **16** of the cylinder head. Secured to this outer wall **16** is a modular exhaust manifold **18** made up of low-stress shielded exhaust passage assemblies. These assemblies include an outlet passage assembly **19**, a center passage assembly **20** and an inlet passage assembly **22**, all formed in accordance with the invention and shown individually in FIGS. **2**, **3** and **4**.

The center passage assembly **20**, shown in FIG. **2**, preferably includes a cast housing having male and female connecting ends **24**, **26**, respectively, and a flanged inlet end **27**, all interconnected by an internal cavity **28**. At the housing ends in the cavity there are internal cylindrical counterbores **30**, **31**, **32** in which are disposed associated bearing rings **34**, **35**, **36** respectively. For purposes to be subsequently made clear, the ring **34** at the male end protrudes beyond the counterbore **30**, the ring **35** at the female end is recessed from the end of the counterbore **31** and the ring **36** at the flanged inlet end extends flush with the end of the counterbore **32**.

Within the cavity **28** and seated on the bearing rings **34–36**, there is a tubular internal passage defining shield **38**. This shield is essentially coextensive with the cavity **28** and includes three associated ball ends **39**, **40**, **42** seated respectively on the bearing rings **34**, **35**, **36**.

Intermediate the ball ends, the exterior of the shield **38** is of slightly reduced diameter so as to provide a clearance **43** between the exterior of the shield **38** and the interior of the cavity **28**. The clearance **43** is of any suitable dimension and is preferably selected to provide an optimum thickness heat insulating dead air space to minimize the transfer of heat from the passage defined by the interior of the shield **38** to the housing which internally defines the cavity **28**.

The inlet and outlet end passage assemblies **22**, **19**, respectively, are constructed in fashion similar to that of the center passage assembly **20** just described. Accordingly, description of these assemblies will avoid repetition of similar detail and concentrate upon the differences in the constructions.

The inlet passage assembly **22** includes a housing **44** which has a male connecting end **46**, a flanged inlet end **47** and internally defines a curved cavity **48**. Counterbores **50**, **51** at the ends are respectively provided with inserted cylindrical bearing rings **52**, **54** which respectively protrude and are flush with the ends of their respective counterbores. An internal shield **55**, having outlet and inlet ball ends **56**, **58** seated on the bearing rings **52**, **54**, respectively, also includes a reduced diameter intermediate portion forming a clearance **59** between the inner cavity defining wall of the housing **44** and the outer surface of the shield **55**.

In similar fashion, the outlet end passage assembly **19**, shown in FIG. **4**, includes a housing **60** having an outlet end **62**, a female connecting end **63** and an inlet end **64**. Counterbores **66**, **67**, **68** in the ends are provided with bearing rings **70**, **71**, **72** respectively which are flush with or, in the case of ring **71**, recessed in their counterbores. A shield **74** within the cavity has ball ends **75**, **76**, **78** seated on the bearing rings **70**, **71**, **72** respectively. A reduced diameter portion intermediate the ball ends

defines an insulating clearance **79** between the shield and the inner wall of the cavity **65**.

In installation of the manifold on an engine, the individual passage assemblies **19**, **20** and **22** are secured to the cylinder head **11** with their inlet passages aligned with the respective exhaust ports **12**, **13**, **15**. Bolts **80**, or the like, extend through the flanges of the flanged inlet ends **27**, **47**, **64**, to retain the assemblies **19**, **20**, **22** against the outer wall **16** of the head **11**.

During installation, the individual assemblies are interconnected, the male connecting ends **24**, **46** of assemblies **20**, **22** being inserted within the female connecting ends **63**, **26** of assemblies **19** and **20**, respectively. Also, the protruding portions of bearing rings **34**, **52** extend into the spaces left by the recessed bearing rings **71**, **35** to aid in properly aligning the internal passages defined by the interconnected assemblies and their inner shields **74**, **38**, **55**. Preferably, high temperature seals **81** are installed in annular gaps between the male and female housing ends to prevent external leakage of exhaust gases through these expansion joints.

As assembled, the separate housing elements making up the exhaust manifold are permitted some relative motion due to the expansion joints between them which are sealed by the seals **81**. In addition, the separate shield members **74**, **38**, **55** within the housing are free to expand or contract relative to their housings with free movement being permitted by sliding motion of the ball ends on their respective bearing rings.

Gaps **82** are provided between adjacent ends of the shields and between the inlet ends of the shields and the adjacent wall **16** of the cylinder head to provide freedom for longitudinal expansion of the inner shields without engaging one another or the cylinder head wall. If desired, these gaps may be closed by suitable high temperature seal members. As an example, FIG. **5** illustrates a connecting joint between passage assemblies **19** and **20** with a seal in the form of a spring steel ring **83** added.

Various alternative embodiments of the bearing rings and connecting end portions of the shield members may be provided as indicated, for example, in FIG. **6** wherein an alternative embodiment of passage assembly is illustrated. In this embodiment, numeral **86** represents a housing, such as an engine cylinder head, defining an exhaust port **87** opening to an outer wall **88**. A bearing ring **90** is mechanically locked by projections **91** into an annular recess at the outer end of the exhaust port and receives a cylindrical end **92** of a shield **94** disposed within the exhaust port **87**. A radial lip **95** on the bearing ring prevents the shield **94** from sliding out of the port while allowing room for relative expansion of the shield with respect to the cylinder head housing **86**.

A cylindrical end **92** may be utilized instead of a ball end at locations where it is expected that longitudinal motion of the associated parts will be sufficient to accommodate relative expansion and substantial bending or other expansion effects will not be encountered.

The construction of an exhaust manifold, cylinder head or other passage assembly having the features of the invention so far disclosed may be accomplished in any suitable manner.

A preferred method of making embodiments of the invention as specifically heretofore disclosed is to first form the shield members, such as by casting and, if necessary, machining the ball or cylindrical ends. Thereafter, the individual shield members are encapsulated within sand core material formed with a thickness about the shield members equal to the clearance desired between the shield and the outer housing. At this time the bearing rings may also be placed in position on the ball ends and sand core material packed in to fill any gaps desired to be left between the end portions of the shields and the bearing rings.

Subsequently, the prepared inserts are placed in molds and the outer housings of the passage assemblies are cast thereabout using cast iron, steel, aluminum or other suitable material.

Finally, the cast assemblies are removed from their molds and cleaned, the core sand being removed from the insulating spaces inside the housings and surrounding the shields. If desired, such sand removal may be accommodated by providing in the ball ends, or in the bearing inserts, longitudinal grooves or spaces, not shown. Final machining of the ends of the housings and bearing rings to properly fit with one another or their associated elements may then be accomplished and the assemblies are thus ready for installation on an engine or the like.

It should be understood that numerous changes or modifications of the concepts disclosed herein could be provided, if desired. For example, the housing members could be provided with flanges, not shown, at their associated male and female connecting ends. The flanges could then be bolted together so that a complete manifold assembly would be provided for installation on an engine as one unit rather than a series of separate assemblies. Such an arrangement would eliminate the relative expansion provision for the separate housing units but would permit relative expansion of the internal shield elements in the same manner as previously described.

While the invention has thus been described by reference to certain specific embodiments chosen for purposes of illustration, it is intended that the invention not be limited solely to the described embodiments but that it have the full scope permitted by the language of the following claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

**1**. A low-stress exhaust passage assembly for an internal combustion engine, said assembly comprising

a housing defining a passage for the transmission of engine exhaust gases therethrough, the passage having at least two spaced ends opening outwardly of the housing,

internal bearing means in the housing at each of said ends, at least one of the bearing means being of at least part-cylindrical form, and

a tubular shield within the passage and extending between said spaced ends, said shield having ball-like ends, one engaging each of the bearing means to fix the lateral position of the shield within the passage, said ball-like shield ends providing slip joints within their associated bearing means to allow freedom for rotational motion, and said at least part-cylindrical bearing means also permitting free axial motion of its associated ball-like end.

**2**. An assembly as in claim **1** wherein the passage includes a directional change between its ends, the bearing means at said spaced ends being non-coaxial.

**3**. An assembly as in claim **1** wherein the passage includes at least one branch, each such branch including one of the passage ends provided with said bearing

means, said bearing means of each said branch being additionally of at least part-cylindrical form.

4. An assembly as in claim 1 wherein said ball-like ends are part-spherical and said bearing means comprise separate rings.

5. An assembly as in claim 1 wherein said housing is cast around said bearing rings with said shield in place.

6. A low-stress exhaust manifold assembly for an internal combustion engine, said assembly comprising

a plurality of housings each defining a passage for the transmission of engine exhaust gases therethrough, each passage having at least two spaced ends opening outwardly of its respective housing, said housings being connectable to form a single housing assembly with a continuous passage therethrough, internal bearing means in each housing at each of said ends, at least one of the bearing means of each housing being of at least part-cylindrical form, and

a tubular shield within each passage and extending between its spaced ends, each said shield having ball-like ends, one engaging each of the bearing means to fix the lateral position of the shield within its associated passage, said ball-like shield ends providing slip joints within their associated bearing means to allow freedom for rotational motion and said at least part-cylindrical bearing means each also permitting free axial motion of their associated ball-like ends.

7. An assembly as in claim 6 wherein the passage of at least one of the housings includes at least one branch, each such branch including one of the passage ends provided with said bearing means, said bearing means of each said branch being additionally of at least part-cylindrical form.

8. An assembly as in claim 7 wherein said ball-like ends are part-spherical and said bearing means comprise separate rings, each said housing being cast around its bearing rings with its respective shield in place.

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